

Effect of multimedia interventions on children's fruit and vegetable consumption in a real-life setting

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Abstract

Purpose – This paper aims to examine the effect of a food-inspired multimedia intervention on children's fruits and vegetables (F&V) consumption in a real-life setting during lunch.

Design – Children in an elementary school in Bologna (Italy) in third, fourth and fifth grade, aged between 9 and 12 years old, were examined (N = 171). Two different types of messages (generic and specific) were used to test message-tailoring in two separate intervention groups and one control group. The two intervention groups (classes) were presented with multimedia messages during an English lesson before lunchtime, and their eating behavior during lunch at school was observed. All children were served the first and second course, vegetables and fruit during lunchtime. Data was analyzed with R 3.4.2. Mann-Whitney U, Kruskal-Wallis and ANOVA tests were used to test for group differences, ordered logistic regression for modelling fruit and vegetable consumption.

Findings – The results show that children receiving a specific message targeting F&V consumed more fruit than the other two study groups. No effect on vegetable consumption was observed. Results from an ordered logit model support the notion that the multimedia message impacted fruit intake in the specific message group when taking other variables into account, such as F&V consumption and availability at home and children's attitude toward F&V.

Originality – While many studies have considered a group of intervention for understanding the effect of multimedia, this study is focused only on the effect of a message (generic or specific). Moreover, participants, children, were not informed that they were participating in a study on fruit and vegetables consumption, and thus were following their daily routine.

Keywords Consumption, Children and food, Fruits, Multimedia, Vegetables

Paper type Research paper

1. Introduction

Following a diet rich in fruits and vegetables (F&V) is becoming a challenge for modern society, and considering the fact that a healthy and balanced diet during youth is crucial for health across the lifespan, this becomes a real concern. These concerns are especially important for children because in Western countries, the level of consumption of F&V among them is low, two–three servings/day compared to the suggested five servings/day (Evans *et al.*, 2012), which is consumed only by 8.8% of the European children (Kovács *et al.*, 2014). However, a recent study suggests that the consumption of fresh F&V varies between the regions (Williams *et al.*, 2020). The study shows that fruit consumption is higher compared to vegetables. In addition, daily consumption of fresh F&V is highest in the Southern and Northern European countries and low in Central Asian countries (Williams *et al.*, 2020).

In light of this evidence, worldwide governments and international institution are aiming to improve the situation, especially in school environments where children spend a high

amount of time (Lane *et al.*, 2020) and because lunchboxes served at school seem to contain fewer macro- and micronutrients than lunchboxes prepared at home (Vargas *et al.*, 2013). From 2009, the European Union implemented the School F&V Scheme. This scheme aims to improve and increase the consumption of F&V in schools by providing them F&V and encouraging member states to implement educational campaigns. Results indicate that this campaign has been successful (Methner *et al.*, 2017) even though children had a lower probability of choosing a slice of apple over cookies. Thus, the increased consumption of F&V is likely due to the higher availability and exposure rather than a real preference (Staudigel *et al.*, 2019).

Another possible way to improve consumption habits is to use different types of communication tools to reach children more effectively. Numerous previous studies have shown that mass media are an effective tool for influencing food choices. Giese *et al.* (2015) found that higher exposure to “unhealthy” food commercials was associated with a higher intake of “unhealthy” snacks. The same study also reported that exposure to healthy food commercials was positively correlated with the respective consumption of F&V.

A multimedia approach to learning and education is increasingly popular in many fields, and audio-visual support to integrate written materials and oral presentation is now widespread (Alberts and Stevenson, 2017; Mwinyi *et al.*, 2017), especially after the COVID-19 pandemic (UNICEF, 2020). A multimedia approach is an approach using, involving or encompassing several media, such as videos, games and podcasts, in learning and education. Because multimedia products are nowadays an important part of the leisure time activities of most children (Hastings *et al.*, 2006), they might be used as an effective tool for the promotion of certain consumption behaviors. Private companies in the food industry sector often use multimedia dissemination strategies. For example, Harris *et al.* (2012) estimated that food company websites with advergames are visited from approximately 1.2 million children monthly in the USA. They mostly promote food with low micro nutrients and high sugar and fat. Harris *et al.* (2012) argue that visiting these websites might facilitate the intake of the promoted food items (Folkvord *et al.*, 2013).

While multimedia seems to be a promising communication tool for interventions, the outreach to the target population is another crucial factor. In Italy, around 4.3 million school meals are distributed daily (He and Mikkelsen, 2009). Thus, school meals are an important leverage point for reaching children. The Food Dudes program in the UK and Ireland [1] aims to examine if only the presence of F&V during lunchtime or other interventions might affect the consumption of F&V among children. At the experimental school, they presented F&V during lunchtime and adopted some other interventions such as peer-modelling videos and rewards and home packs for parents. At the control school, they presented only F&V. The results suggested that the consumption of F&V increased significantly at the experimental school, while at the control school, the consumption increased moderately. Nevertheless, the study does not show which between the two factors, multimedia and rewards or parents’ knowledge, affects more the consumption of F&V among children. In line with this, Sirikulchayanonta *et al.* (2010) found that multimedia and parents’ support have an important impact on children’s consumption of F&V. Other studies have shown that using different strategies at once and each strategy implemented separately do not significantly impact increasing fruit and vegetable consumption (Thompson *et al.*, 2017; Wordlaw and Vilme, 2022).

The FoodDudes project was also implemented in Italy, in the regions of Lombardy and Sicily [2]. Results indicate that 90% of participants (children) have significantly changed their eating attitudes, and 85% ask their parents to buy F&V. Moreover, 82% of teachers have also changed their eating attitudes by adopting a more equilibrated and healthy diet.

Although most studies have noticed the important role of multimedia, they did not investigate whether the consumption of F&V is equally affected by generic (e.g. “eat healthily”) or specific (e.g. “eat fruit”) information.

Thus, this study’s objectives are to examine whether multimedia, in the form of audio-visual materials included in a class, could influence children’s eating habits at lunch and whether both a generic and a specific message would work. The study results can inform whether multimedia could be used as an alternative way to communicate positive messages and educate children about healthy food.

We test a food-inspired multimedia intervention on children’s F&V consumption in a real-life school setting. Two intervention groups and one control group were examined. To test message-tailoring effects, we selected two different types of messages (generic and specific). We assumed the effectiveness of communication is affected by how the message is tailored:

- H1.* Children who watch multimedia featuring F&V (behavioral specific or generic) consume more F&V during lunchtime than the control group.
- H2.* Children who watch multimedia with a specific, behavioral tailored message (focusing on F&V) consume different amounts of F&V during lunchtime than children who watch multimedia with a generic message (healthy eating including F&V).

2. Methods

2.1 Participants and sampling

Children were recruited using convenience sampling from a private school in Bologna, Italy. As agreed with the school principal, we aimed to change the daily routine as little as possible as a general criterion for designing and implementing the intervention and related observations. Therefore, children were assigned to the three study groups based on their classes. We preferred this solution because, although randomly assigning children from different classes to each treatment might have been useful for statistical tests, it would have also determined a significant change in the daily routine because children usually sit with their classmates.

All third-, fourth- and fifth-grade students were eligible to participate if their parents did not opt-out. In total, 171 children were included in the study, and all eat school-provided lunch daily. Their ages ranged from 9 to 12 years ($M = 10.1$, $SD = 0.9$), with 57% being boys. Each treatment group comprised a class of students from each grade (three classes): Control group ($n = 59$, classes – 3B, 4C and 5B); intervention group 1 or Tr.1, “specific messages” ($n = 58$, classes - 3A, 4B and 5C); and intervention group 2 or Tr.2, “generic messages” ($n = 54$ - classes 3C, 4A, 5A). Children were assigned IDs to ensure anonymity. Parents who agreed that their children participate in the study were asked to complete a brief questionnaire regarding their children’s food consumption and demographic information.

Despite using a convenience sample, we applied power analysis to evaluate the sample size in each treatment. For three groups, for a significance level of 5% and power of 80% we obtained an $n = 52.4$. On average for each treatment we have 57 observations.

2.2 Materials

2.2.1 *Questionnaire for parents.* The questionnaire [3] comprised:

- children’s sociodemographic (age, weight and height);
- children’s food consumption behavior (Cullen *et al.*, 2001; Lohse and Cunningham-Sabo, 2012);

- children's food attitudes ([Anderson et al., 2012](#); [Lohse and Cunningham-Sabo, 2012](#));
- children's usage of multimedia ([Kelder et al., 2005](#));
- parents' attitude toward F&V consumption ([Christian et al., 2013](#); [Musher-Eizenman and Holub, 2007](#));
- availability of F&V at home ([Musher-Eizenman and Holub, 2007](#)); and
- parents' sociodemographic information.

2.2.2 Multimedia. As requested by the school principal, the multimedia used in this study was in English, and the VDOs were presented to the children as part of the normal teaching activity to learn English as a foreign language. Two different episodes from the series *Sesame Street* were chosen because it is a worldwide well-known American educational children's television series, which has local versions in a large number of countries all over the world. In Italy, the series was aired under the title *Sesamo apriti*. This TV show has a wide choice of stories and this allowed selecting for the two interventions:

1. A story more specifically focused on the importance of consuming fruit, which is our target food, episode "Fruit snack samba" [4], which was introduced to Tr.1.
2. A story about eating well in general, episode "Breakfast is the most important meal of the day" [5], which was introduced to Tr.2.

The control group was not exposed to multimedia messages during the English class.

2.2.3 Ethics. The study was approved by the University of Bologna ethical committee and has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki ([The World Medical Association, 1989](#)) and its later amendments. Fully-informed parental consent was provided. All study protocols, materials (VDOs) and questionnaires were approved by the principal, teachers and parents.

2.3 Procedure

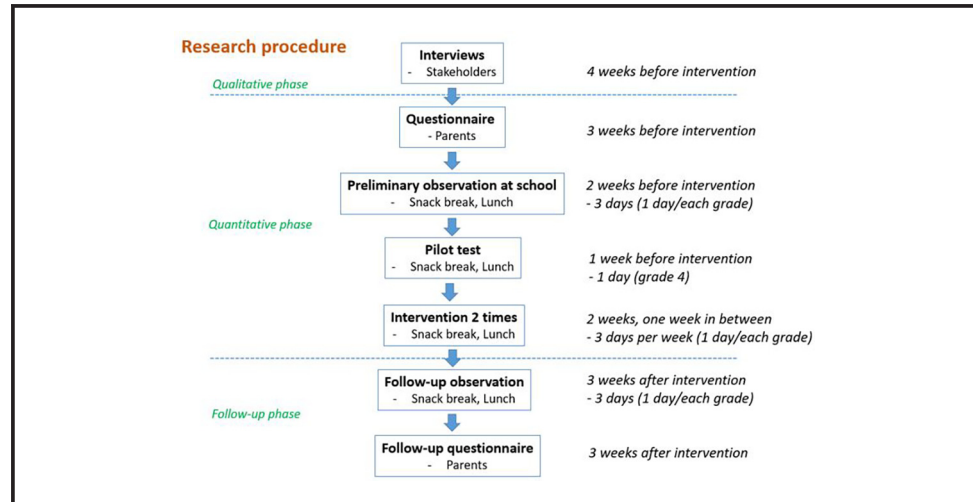
The study comprised three phases:

1. qualitative pre-study;
2. intervention; and
3. follow-up.

[Figure 1](#) summarizes the different steps involved in developing the study protocol and the implementation of the intervention study.

2.3.1 Pre-study: qualitative interviews with stakeholders, including parents, teachers, school caterers and school dieticians. Qualitative interviews with stakeholders at the school were administered to understand how the school was organizing its class activities and canteen operations. This step was necessary for designing the intervention study. In February 2016, we conducted semi-structured interviews with nine stakeholders in the school: parents ($n=3$ persons); teachers ($n=3$); school food providers ($n=2$); and a school dietician ($n=1$). The interviews included questions about their attitude toward F&V consumption of children; key factors influencing children's consumption of F&V, including potentials and barriers; approaches they used to encourage children to consume food; their attitude toward children's usage of computer, tablet, cellphone and multimedia; and ambience during lunchtime at school. The face-to-face and phone interviews lasted 30–60 min and were recorded with the interviewee's consent. Data were analyzed using a thematic analysis framework outlined by [Bengtsson \(2016\)](#). Based on notes and transcripts of the interviews, researchers identified keywords and themes of emerging issues from the conversations.

Figure 1 Research procedure



Many issues related to perceived motivating and impeding factors for children to consume F&V were identified. The participants thought that children's individual preferences, habits at home, family habits and tastes and their social environment are the factors which mostly affect the consumption of F&V. Moreover, all subjects of this phase (parents, teachers and food providers) frequently asked children to try F&V or new food. All the interviewees thought that children tend to consume F&V that are ready to eat (peeled and cut). Finally, the interaction with adults like parents, teachers or other persons in the school is still very important for children at these ages. A summary of the pre-study results is shown in [Appendix](#). The results from this phase were used as input for the intervention phase, including the survey design, questionnaire design and study protocol.

2.3.2 Intervention study: effect of multimedia interventions on children's fruits and vegetables consumption in real-life setting.

2.3.2.1 Pre-intervention phase. Before conducting the intervention study, a questionnaire regarding children's food consumption behaviors and parents' attitudes (questionnaire for parents) was submitted to the consenting parents, and the observation during lunchtime at the school's canteen was conducted.

The questionnaire was sent to the parents three weeks before the intervention, and all parents returned the filled questionnaires.

Two weeks before the intervention, the unstructured observation at the school during lunchtime was conducted for three days in a roll (one day per grade) to develop the intervention protocol.

One week before the intervention, the protocol was piloted with students in grade fourth and adjusted accordingly. The photos of food leftovers were recorded during the pilot study as well. Afterwards, the researchers brainstormed to decide how to code the amount of food (see details in [equation \(1\)](#)) before the intervention phase.

2.3.2.2 Intervention phase. The study was conducted using a between-subject design. To test whether multimedia influences children's F&V consumption, the multimedia videos (generic or specific) were introduced before lunchtime in the treatment classes and all children's eating behavior during lunch at the school canteen was observed.

The intervention took place in March and April 2016, lasted two days and was repeated twice at a one-week interval. Children from different grades had lunch at the canteen on

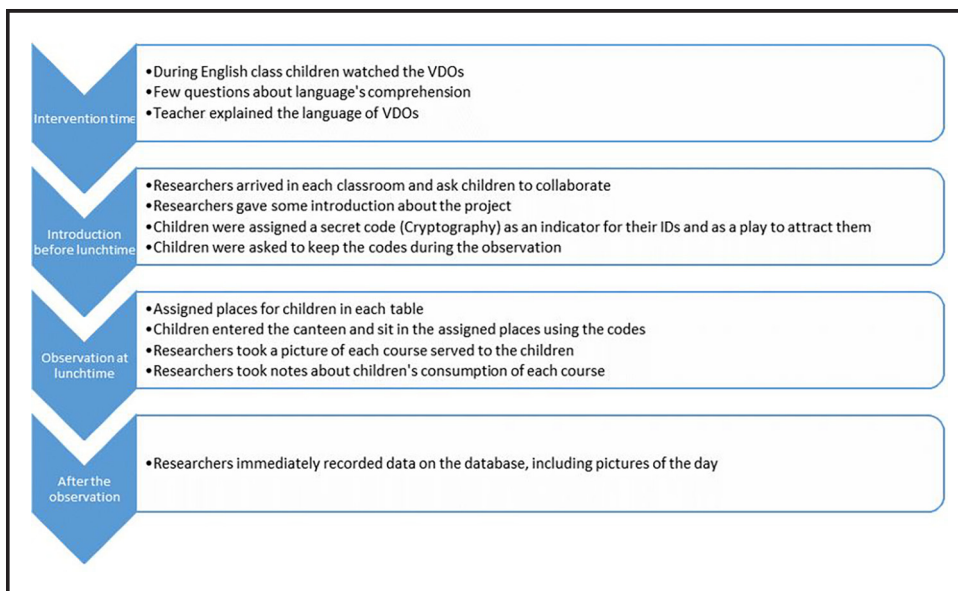
different days (grade 3 had lunch on Tuesday, grade 4 on Wednesday and grade 5 on Thursday). Therefore, we mixed children from different grades in the same treatment group, and different menus were offered along the intervention days.

The children were unaware that they watched different intervention materials to minimize possible demand effects (e.g. that they should behave differently on the intervention days). When they interacted with the researchers, the children were informed that the study was about children’s food consumption in elementary school; they were not informed that the focus of the study was their consumption of F&V to avoid participant bias.

Episodes were shown to the kids on the same day of the first intervention, during the English language class. The teachers ensured that children did understand the VDOs, that the messages were simple and that they could have asked if they did not understand some words. However, the content of the VDOs was not discussed in the class to avoid possible demand effects. The intervention was repeated for the second time in the following week using the same protocol. [Figure 2](#) summarizes the intervention procedure applied during the intervention day.

The regular menu choices offered at lunch were presented in the following order: first course (carb – rice or pasta), second course (protein – eggs or fish or meat) with side dishes (raw or cooked vegetables) and fruit. Potatoes are counted as vegetables because we use side dishes as a proxy for vegetable consumption. The caterer who prepared the food reliably served all children an equal amount of food. Therefore, all children received an equal portion of the first and second courses, including side dishes. They were free to request a second helping of each course and side dish. In addition, they could also choose to have fruit and, if they wished, ask for a second helping of fruit. The school had the policy to serve a rotation menu; hence, the menu on two intervention days and in different treatments was different. We observed children during their morning snack and lunchtime. The amount and type of food consumed were recorded using photos and notes ([Bontrager Yoder et al., 2014](#); [Swanson and Beebe-Frankenberger, 2004](#); [Taylor et al., 2014](#)) so that observers did interfere as less as possible with children’s activities. Each student was assigned a code tag to trace individual food intake during the

Figure 2 Intervention procedure



intervention. The secret codes were changed from the first to the second intervention time.

2.3.3 Follow-up study: remaining effect of multimedia interventions on children's fruits and vegetables consumption. Three weeks after the last intervention day, a follow-up day was conducted using the same protocol, without intervention, to test for possible carryover effects (i.e. eating behavior of children). In addition, a follow-up questionnaire was sent to the parents. The post-intervention questionnaire assessed children's attitude toward food and response to the multimedia (e.g. whether they remembered and liked the VDOs).

2.4 Statistical analysis

Data were analyzed using the statistical software R 3.4.2 (R Core Team 2017). Observed amount of food consumption was measured and coded as follows: 1 = do not finish the dish (or fruit) at the first round; 2 = finish the first round; and 3 = take the second round ("bis" or "second"), no matter whether they finish it or not. Consumption of the first course, second course, vegetables and fruit were coded in the same way. Because vegetables available at lunch were part of the side dish, we used the consumption of side dishes as a proxy for vegetables consumption. Mann–Whitney U, Kruskal–Wallis and ANOVA tests were used to test for group differences, depending on the nature of the variables.

To model children's F&V consumption, ordered logistic regressions were conducted with the amount of vegetables or fruit consumed during the lunchtime assessments (ordinal variable) as dependent variable. The independent variables were: the amount of food children consumed (ordinal value) before they consumed vegetables or fruit (the first course and the second course for vegetables; the first course, the second course and vegetables for fruit); children's attitude toward fruit or vegetables; frequency of F&V consumption; and F&V availability at home. Panel data from the first, the second intervention and the follow-up were used in this analysis.

The general ordered logit model for F&V consumption of children was expressed as follows:

$$Q_i^* = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \varepsilon_i \quad (1)$$

where:

$$Q_i = \begin{cases} 1 & \text{if individual did not finish the dish (or fruit) at the 1st round} \\ 2 & \text{if individual finished the 1st round} \\ 3 & \text{if individual took the 2}^{nd} \text{ round, no matter they finish it or not} \end{cases}$$

where Q_i^* is individual F&V consumption; X_{1i} is an experimental group (control group as baseline); X_{2i} is a set of explanatory variables representing individual consumption of the first course, the second course and side dish (only for fruit consumption); X_{3i} represents children attitude, frequency of consumption and availability at home. All unobserved influences are captured in the error term ε .

Model specification for vegetables consumption is as follows:

$$Q_{V^*i} = \beta_0 + \beta_1 Tr + \beta_2 FirstCourse_i + \beta_3 SecondCourse_i + \beta_4 Attitude_V_i + \beta_5 Frequency_V_i + \beta_6 Availability_FV_i + \varepsilon_{ijt} \quad (2)$$

Model specification for fruit consumption is as follows:

$$Q_{F^*i} = \beta_0 + \beta_1 Tr1 + \beta_2 FirstCourse_i + \beta_3 SecondCourse_i + \beta_4 Q_{vi} + \beta_5 Attitude_F_i + \beta_6 Frequency_F_i + \beta_7 Availability_FV_i + \varepsilon_{ijt} \quad (3)$$

where $i=1, \dots, N$ is the number of the participants; $Q_{V_i}^*$ is individual vegetables consumption (ordinal from 1 to 3); $Q_{F_i}^*$ is individual fruit consumption (ordinal from 1 to 3); β_0 is an intercept; Tr is experimental treatment; $FirstCourse_i$ is consumption of first course (ordinal from 1 to 3); $SecondCourse_i$ is consumption of second course (ordinal from 1 to 3); $Attitude_{V_i}$ is attitude toward vegetables consumption; $Attitude_{F_i}$ is attitude toward fruit consumption; $Frequency_{V_i}$ is frequency of vegetables consumption at home; $Frequency_{F_i}$ is frequency of fruit consumption at home; $Availability_{FV_i}$ is availability of F&V at home; and ε_{ijt} is an error term.

In further models, other variables were added, including sociodemographic and attitude variables. Because these models did not significantly improve the fit, only the results of the model described above are provided.

3. Results

3.1 Sample characteristics

The majority of children were in the normal weight range. As Table 1 shows, the three groups did not significantly differ with respect to gender, age, weight status or other variables.

Regarding F&V consumption habits, parents reported that they often prepare F&V at home and that their children consume F&V at least once a day (see Table 2).

The Kruskal–Wallis tests show no statistically significant differences between the three study groups.

3.2 Food consumption at lunchtime by study groups

The average and median of food consumed during lunchtime on the first intervention day, the second intervention day and the follow-up day are reported in Table 3. In general, the children consumed more carbs (first course) and protein (second course) than F&V (side dishes), respectively. Kruskal–Wallis rank sum tests showed that children at different ages significantly differed in their consumption of vegetables.

Mann–Whitney U tests were used to test $H1$, comparing F&V consumption between the two intervention groups and the control group. Results show that children in intervention group 1 who received a F&V tailored multimedia message consumed more fruit than children in the control group ($z=3.578$, $p<0.001$, $r = 0.191$), supporting our first hypothesis that

Table 1 Sociodemographic characteristics

Characteristics	Control group (n = 59)	Specific message group (n = 58)	Generic message group (n = 54)	K–W test p-value ^a	Total sample (N = 171)
<i>Gender (N = 171)</i>				0.835	
Female (%)	40.68	43.10	46.30		43.27
Male (%)	59.32	56.90	53.70		56.73
<i>Age (M, SD) (n = 161)</i>	10.15 (0.89)	10.12 (0.86)	10 (0.82)	0.642	10.09 (0.86)
<i>Weight status (MD)(n = 149)</i>	Normal weight	Normal weight	Normal weight	0.581	Normal weight
Underweight (%)	8	9.62	4.26		7.38
Normal weight (%)	82	75.00	80.85		79.19
Overweight (%)	10	9.62	6.38		8.72
Obesity (%)	0	5.77	8.51		4.70
<i>Household size (MD)(n = 161)</i>	4	4	4	0.259	4
<i>Siblings (MD) (n = 160)</i>	1	1	1	0.237	1

Notes: Weight status of subjects was evaluated using the criteria of BMIs of children at different genders and ages developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion in 2000. ^aComparison of medians among treatments using Kruskal–Wallis rank sum tests except for age we used ANOVA test for mean comparison. *, ** and *** denote significant difference at the 0.10, 0.05 and 0.01 levels, respectively

Table 2 Consumption habits and F&V availability at home reported by parents (pre-intervention)

Characteristics	Control group (n = 59)	Specific message group (n = 58)	Generic message group (n = 54)	K-W test p-value ^a	Total sample (N = 171)
<i>Vegetables consumption (MD) (n = 162)</i>	3	3	2	0.711	3
0, Never or rarely (%)	12.73	7.27	15.38		11.73
1, 1–3 times a week (%)	21.82	10.91	13.46		15.43
2, 4–6 times a week (%)	14.55	29.09	23.08		22.22
3, Once a day (%)	23.64	30.91	26.92		27.16
4, More than once a day (%)	27.27	21.82	21.15		23.46
<i>Fruit consumption (MD) (n = 161)</i>	3	3	2	0.180	3
0, Never or rarely (%)	9.09	9.09	9.80		9.32
1, 1–3 times a week (%)	20.00	14.55	33.33		22.36
2, 4–6 times a week (%)	18.18	18.18	13.73		16.77
3, Once a day (%)	29.09	27.27	23.53		26.71
4, More than once a day (%)	23.64	30.91	19.61		24.84
<i>F&V availability at home (MD) (n = 161)</i>	3	3	3	0.821	3
0, Never (%)	1.85	0	1.92		1.24
1, Occasional (%)	7.41	5.45	15.38		9.32
2, Frequent (%)	12.96	12.73	15.38		13.66
3, Often (%)	29.63	40	19.23		29.81
4, Always (%)	48.15	41.82	48.08		45.96

Notes: ^acomparison of medians among treatments using Kruskal–Wallis rank sum tests. *, ** and *** denote significant difference at the 0.10, 0.05 and 0.01 levels, respectively

Table 3 Food consumptions during lunchtime by study groups

Meal course	Control group (n = 59)			Specific message group (n = 58)			Generic message group (n = 54)			K-W test p-value ^a	Total sample (N = 171)		
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median		Mean	SD	Median
First course	2.26	0.801	2	2.19	0.770	2	2.44	0.669	3	0.019**	2.29	0.760	2
Second course	2.13	0.774	2	1.93	0.800	2	2.17	0.774	2	0.013**	2.07	0.798	2
Vegetables	1.60	0.731	1	1.72	0.771	2	1.62	0.704	1	0.369	1.65	0.738	1
Fruit	1.67	0.711	2	1.94	0.704	2	1.66	0.715	2	<0.001***	1.76	0.721	2

Notes: Panel data from the first, second intervention and follow-up were analyzed. Amounts of food were coded as ordinal variables: 1 = do not finish the dish at the first round; 2 = finish the dish at the first round; 3 = take the second round of the dish, no matter they finish it or not. Consumption of vegetables was from the consumption of side dishes. ^aComparison of medians among treatments using Kruskal–Wallis rank sum tests. *, ** and *** denote significant difference at the 0.10, 0.05 and 0.01 levels, respectively

multimedia featuring F&V influences F&V intake. However, children in intervention group 2 who received a generic health-related multimedia message did not significantly consume more F&V than the control group.

The Mann–Whitney U test was used to test *H2*, comparing F&V consumption between the two intervention groups. The second hypothesis was confirmed as intervention group 1 consumed significantly more fruit than intervention group 2 ($z = 3.493$, $p < 0.001$, $r = 0.191$). This pattern of results supports the notion that tailoring multimedia messages to the behavioral domain is more effective than generic messages.

In an additional step, consumption differences for the different courses were tested. The intake amount for the first ($\chi^2 = 7.953$, $p = 0.019$) and the second ($\chi^2 = 8.661$, $p = 0.013$) course differed between the study groups. Intervention group 1 (specific message) consumed less during the first ($z = -2.866$, $p = 0.004$, $r = 0.156$) and second course ($z = -2.651$, $p = 0.009$, $r = 0.145$) as compared to intervention group 2 (generic message).

Moreover, intervention group 1 consumed less than the control group during the second course ($z = -2.386, p = 0.019, r = 0.127$).

Control analyses. To ensure the observed pattern of results, additional control analyses were conducted.

Comparing food consumption at different intervention times – the first intervention, the second intervention and follow-up (Table 4), no significant differences emerged except for the consumption of the second course ($\chi^2 = 16.172, p < 0.001$) with a higher consumption at the second intervention day as compared to the first intervention day ($z = 2.623, p = 0.009, r = 0.140$) and the follow-up ($z = 0.3932, p < 0.001, r = 0.215$). However, F&V consumption remained the same across different intervention days.

Analyses between school classes did not show marked consumption differences. Only children in class 4 A consumed less vegetables than class 5B, $\chi^2 = 10.996, p = 0.004$ and more fruit than class 3 C and 5 A, $\chi^2 = 14.803, p = 0.001$. Children in class 4B consumed less fruit than in class 5 C, $\chi^2 = 8.926, p = 0.012$. Therefore, systematic peer effects were not observed.

3.3 Determinants of fruit and vegetable consumption

To test the robustness of the experimental effect, a more comprehensive data analysis was conducted with ordered logit estimations. Results are depicted in Table 5.

Consistent with the previous analysis, children of treatment group 1, who watched specific messages via multimedia, often consumed fruit during lunch. In addition, eating habits at home (consuming fruit at least four–six times a week) and positive attitudes toward F&V were positively associated with fruit consumption.

However, the experimental group did not significantly affect vegetable consumption during lunchtime. Vegetable intake was significantly related to the consumption of the second course. This is probably because vegetables or side dishes were served together with the second course. Thus, children who consumed the second course tended to consume vegetables, too. Moreover, consuming vegetables at least four–six times a week at home, and F&V availability at home was positively associated with vegetables intake at lunchtime.

4. Discussion and conclusions

This study examined the impact of multimedia on children’s eating behavior, particularly on their F&V consumption, to understand whether it could be used to facilitate healthy eating in children. Results indicate that multimedia featuring F&V positively affected children’s consumption of fruit during lunchtime while it did not change their vegetable consumption. The observed pattern of results is consistent with other studies showing that multimedia usage affects fruit but not vegetable consumption (Blanchette and Brug, 2005; Labyak et al., 2021; Laureati et al., 2014). One reason for this different consumption effect might be

Table 4 Food consumptions during lunchtime by measurement point in time

Food course	Intervention day 1 (N = 171)			Intervention day 2 (N = 171)			Mean	Follow-up (N = 171)		K–W test p-value ^a
	Mean	SD	Median	Mean	SD	Median		SD	Median	
First course	2.27	0.761	2	2.39	0.730	3	2.21	0.777	2	0.082
Second course	2.04	0.774	2	2.27	0.785	2	1.92	0.773	2	< 0.001***
Vegetables	1.68	0.722	2	1.65	0.765	1	1.61	0.729	1	0.677
Fruit	1.79	0.732	2	1.75	0.677	2	1.75	0.754	2	0.842

Notes: Amounts of food were coded as ordinal variables: 1 = do not finish the dish at the first round; 2 = finish the dish at the first round; 3 = take the second round of the dish, no matter they finish it or not. Consumption of vegetables was from the consumption of side dishes. ^a Comparison of medians among treatments using Kruskal–Wallis rank sum tests. *, ** and *** denote significant difference at the 0.10, 0.05 and 0.01 levels, respectively

Table 5 F&V consumption at lunchtime in dependence of the treatment group, menu course, attitudes and habitual consumption (ordered logit estimation)

Variables	Vegetable consumption		Fruit consumption	
	Mean	S.E.	Mean	S.E.
Intercept	-4.193***	0.678	-2.098***	0.711
Treatment 1	0.384	0.298	0.956***	0.355
Treatment 2	-0.042	0.307	0.114	0.367
first course consumption	0.151	0.154	0.101	0.164
second course consumption	0.813**	0.156	0.039	0.160
Side dish consumption	–	–	0.253	0.168
Attitude toward vegetables/fruit consumption	-0.008	0.190	0.677***	0.226
Frequency of consumption at home	1.216**	0.385	0.835**	0.418
F&V availability at home	0.347**	0.158	-0.136	0.156
Number of observation	513	513		
Log-Likelihood	-399.339	-400.810		

Notes: Panel data from the first intervention, the second intervention and follow-up were analyzed. Presented models, ordered logit regression were estimated using R3.3.2. *, ** and *** denote significant difference at the 0.10, 0.05 and 0.01 levels, respectively. Attitude toward F&V consumption, frequency of F&V consumption and F&V availability at home were reported by parents and were treated as ordered variables. Side dish consumption was only an input for determinants of fruit consumption. Control is a baseline for Tr.1 and Tr.2

that fruit is generally sweeter or tend to have sweeter notes, while vegetables have bitter notes. In addition, fruit could be consumed as they are, while vegetables typically need to be cooked; hence, the way vegetables are cooked could have a systematic impact on children's preferences. However, studies have shown that exposure to TV food advertising and advergames shapes children's dietary habits (Russell *et al.*, 2019). In addition, other studies have found that healthy food advertisement and intervention are positively associated with F&V consumption in children (Cullen *et al.*, 2016; Giese *et al.*, 2015; Upton *et al.*, 2013). Therefore, multimedia's effect on vegetables consumption needs to be tested in further research.

Another possible reason that only the VDO in specific F&V tailored message affected fruit consumption might be because of the simplicity of the message. The message focused predominantly on fruit, while the VDO in the generic message group addressed healthy eating, including more aspects than just the consumption of F&V. Hence, the multimedia's messages used for interventions might be more effective if they target only a few and specific elements. This hypothesis could be tested in further research, for instance, by evaluating the effect of VDO focusing on vegetables.

One of the possible explanations, besides of individual preferences, could be because fruit was offered to children at the end of the meal; therefore, it is more likely that children who need more energy or eat more food will consume everything in the meal. Probably to encourage children to eat more F&V, they should be included in the dish in the first part of the meal. In line with this suggestion, Elsbernd *et al.* (2016) show in their study, that serving vegetables first could be a strategy to increase vegetable consumption in elementary school canteens. Children of different ages and classes differed in their food consumption, probably because of individual preferences and peer effects; this result is in line with the study of Laureati and Pagliarini (2019), who reported that the context in which children consume the meal plays an important role for their food choices.

Results of the follow-up phase did not show significant differences in F&V consumption with the intervention phase. This finding suggests that multimedia might still affect children's consumption of F&V. However, due to our decision to use a between-subject design and not measure the consumption of F&V before the intervention, a middle term effect of multimedia cannot be confirmed. Hence, further research should consider the inclusion of measurement before intervention and middle- to long-term repeated measures after the intervention to

capture the effect of multimedia in the medium and long run. Results from the ordered logit model indicate that children who consumed vegetables at home frequently (at least four–six times a week) and whose parents prepared F&V at home meals consumed more vegetables. In addition, children who consumed more of the second course tend to eat vegetables, likely because vegetables were served as side dishes of the second course.

Children in the intervention 1 group, consuming fruit at least four–six times a week at home and having a positive attitude toward fruit consumption, consumed more fruit. These findings confirmed the results from the qualitative phase that factors affecting F&V consumption of children are individual preferences, their habits at home, influence from family and role model in television (in this case, multimedia). Due to the experimental design characteristics, we could not test the peer effect here; further research should also include this issue in the design.

Our study's strengths are that we observed children's behavior in the natural environment without interfering in their activities (except for the researchers' presence). The students only knew that researchers were observing their general food consumption behavior; they did not know that they were participating in an experiment and that the focal aspect was F&V consumption. Therefore, excitement for participating in an experiment and the wish to please the researchers should not have affected their behavior. Furthermore, besides implementing the school intervention, we took into account the cultural effect, namely, order of food courses. Therefore, our results and suggestion could also fit the Italian food culture. Although we did not focus on specific types of F&V (which could affect their consumption for preferences), our results show that fruit consumption has generally increased after the intervention.

Finally, to the best of our knowledge, the generic and specific message effect tested in this study was not considered in other studies, allowing us to fill a gap in the literature. We found that the consumption of F&V increased in the specific message group but not in the generic message group, but this finding requires more research to be confirmed, considering the limitations of this study.

The main limitation is that our study was conducted at one school only, so the results might be specific to the context of this school. Other limitations are inherent to the field experiment nature of this study, which provides constraints to the experimental design. For instance, as requested by the school board, the interference in the regular daily operations was as little as possible, and interaction with children was very limited. Therefore, the experimental design did not include random assignment of children to the groups, food portions were not weighed, leftovers were assessed only visually, children's BMI measures were based on weight and height reported by their parents. Also, we could not control the effect of different menus offered on different intervention days; hence, further research should consider this issue. Despite these limitations, this study could serve as a basis for further research.

Finally, the study was conducted in 2016. In the meanwhile, especially after the COVID-19 pandemic, electronic device usage increased enormously, and their use in schools has been necessary because of restrictions due to lockdowns. Studies have found that influencers affect children's eating habits and calorie intake (Coates *et al.*, 2019a, 2019b; Folkvord and de Bruijne, 2020; Nour *et al.*, 2018) and future studies should further consider this aspect. However, we highlight that the children participating in this study were 10–12 years old, and the legal age for using social media in Italy is now 13 years old.

5. Implications for research and practice

The present study has some policy, industry and society implications. It shows evidence that multimedia with a clear and specific message could be used as a tool to promote F&V consumption among children. This finding is interesting for policymakers and other food-related programs, such as FoodDudes. In line with other studies, we found that the increase in consumption is higher in fruit than vegetables. This finding should be considered carefully, not

only by policymakers but also by researchers who need to look for more effective solutions because vegetable consumption increase is a primary goal. Finally, the finding that F&V availability at home played an important role has important implications for the society and policymakers: information campaigns addressed to young parents (but also to the general population) may increase the level of knowledge about healthy eating and have an indirect improvement effect on children's nutrition.

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Notes

1. www.fooddudes.ie/food-dudes/
2. www.fooddudes.it
3. Full questionnaire is available upon request to the authors.
4. <https://youtu.be/4OMhPR4f2oA>
5. https://youtu.be/LPqvODHZt_c

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Appendix

Table A1 Summary of the pre-study results/role of different factors and the way they affect the eating habits of children

Factors affecting the F&V consumption of children	<ul style="list-style-type: none">● Individual preferences● Habits at home● Family habits and taste● Social environment (i.e. friends at school and role models in television)● Interactions with adults (i.e. parents, teachers and other people at school)
Role of teachers and other adults at school	<ul style="list-style-type: none">● Importance of eating various food and F&V reducing food waste● Focus on roles of food in their growth development● Food as a part of cultural study● Asking children to try F&V● Asking children to try new food
Role of parents	<ul style="list-style-type: none">● Prepare food to build up children eating habits● Educate them about health benefits of food● Giving a good example (role model) of eating habits● Asking children to try F&V● Asking children to try new food
Role of multimedia	<ul style="list-style-type: none">● Depends on length and frequency of usages● Computer usage and multimedia access of children are limited and controlled● Do not use computers/multimedia for getting information about food● Use computers/multimedia entertainment such as playing VDO games● Eating habits could be affected indirectly from actions of famous people, pictures of skinny models or actors/actresses or cooking show (i.e. Master Chef junior)

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